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Life History Parameters of the Humpback Whale (Megaptera novaengliae) in the Waters of the Gulf of Maine for the 2007 Feeding Season

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Meg is a senior Environmental Biology major with minors in Chemistry and Earth Science. She was awarded a 2007 ATP Spring Semester grant and a 2007 ATP Summer grant to complete her research work with humpback whales under the supervision of Dr. John Jahoda and Carol "Krill" Carson. She has also been given the opportunity to be a guest student at Woodshole Oceanographic Institute working with Dr. Saccocia from BSC and Dr. Seewald from WHOI. This work ended with a 5 week research cruise to the Mid-Atlantic to study the chemistry of hydrothermal vent fluid.

The humpback whale (Megaptera novaengliae) *is an endangered species of baleen whale that feeds in the waters of the Gulf of Maine during the spring, summer and fall. The worldwide population of humpback whales ranges from 60,000 to 80,000 individuals[1] and the population within the Gulf of Maine is estimated between 9,000 to 11,000[2]. Humpback whales are a large baleen whale that reaches an average length of 40 to 50 feet and a weight of 35 to 40 tons. Although protected worldwide since the International Whaling Commission in 1964, this population has increased slowly and is still considered a fraction of the pre-whaling population estimates[3]. There are numerous factors that are responsible for this slow recovery and many related to life history parameters for this species. Humpbacks reach sexual maturity at age 4 or 5. Reproductively mature females produce a single calf every 2 or 3 years and invest a large amount of time and energy with their calves offshore. And the gestation period for this species is close to a year[4].*

Humpback whales can be individually identified using photo-identification techniques that involve the comparison of natural body features and pigmentation patterns among individuals. Features used for photo-identification of humpback whales include the dorsal fin, the fin on the back of the whale, and the ventral surface of the fluke, which is the tail of the whale. Individual humpbacks have a unique size and shape to their dorsal fin and may also have scars or marks on the fin that are unique to that individual. Photo-identification techniques also focus on the ventral or bottom surface of the tail, called the fluke. This surface has a black and white pigmentation pattern that varies from one humpback to another. Some individuals have a ventral fluke pattern that is predominantly white, while others have a pattern that is predominantly black. However, most individuals have a pattern that is in between these two extremes. The white and black lines in this pattern as well as blotches and other marks can be used as a sort of "fingerprint" that allows for comparison among individual humpback whales.

Photographs of the dorsal fin and the ventral fluke allow the creation of catalogs of known individuals that can be used for long-term studies of this species. The photo-identification technique for the humpback whale is one of the simplest when compared to other species of large baleen whale. This combined with the fact that humpback whales are a coastal species has meant

that this species has been the focus of the baleen research in both the Atlantic Ocean and the Pacific Ocean for the past 30 years[5].

The overall research focus is to investigate life history parameters of the humpback whale (*Megaptera novaengliae*) that feeds in the Gulf of Maine from March until November. In the lab, work has been done to further develop, refine and maintain Bridgewater State College's humpback whale photo-ID digital catalog that is housed in the Watershed Access Lab (WAL). By learning these photo-identification techniques, one is able to identify individual humpback whales. Then the identified whales are used to update life history parameters and demographics. The fieldwork that was conducted over the summer was done on commercial whale watching vessels as a research assistant.

The significance of this research will not only help the scientists in the immediate area, but throughout the Gulf of Maine. This sighting and demographic information will be shared with other organizations so a more complete picture of the humpback whale population can be formed. Since the humpback whale is listed as an endangered species worldwide, careful watch of the population will have to occur. It is important to know if the population is increasing or decreasing and what measures need to be taken. The information gathered through this research hopefully will be able to help those who have been working in the marine sciences and their own conservation efforts. The hope is to educate others about how what one does has an impact on the environment and many species, including the humpback whale.

Methodology

This research involved extensive work from May until the beginning of September. Data was gathered over the summer of 2007 to determine specific life history demographics. This included which whales have calves within the year in order to update the database to provide a long-term understanding of reproductive frequency and variation among females within the population. This project will also include an analysis of the demographics of feeding behavior to determine which part of the humpback whale population utilized Massachusetts Bay including the waters of the Stellwagen Bank National Marine Sanctuary in the 2007 feeding season. This will allow a determination of the percentage of the population that is male, what percentage is female, what percentage are mother/calf pairs, and related life history traits.

Fieldwork involved working as a research assistant aboard Captain John vessels operating in Cape Cod Bay and Massachusetts Bay from April through October. This involved working for at least five four hour-long trips per week. Photographic-identification techniques were used to collect data from the boats. This data was analyzed using the computer facilities available in the Watershed Access Lab in the Moakley Center. Each time a humpback whale was sighted, its position and behavior was recorded on standardized data sheets. Photographic data was recorded using digital SLR cameras with 300 mm lenses to collect images of the animal that was then used for photo-ID analysis back in the lab.

Laboratory activities have involved the analysis of sighting data and photographic images collected offshore. At least one day a week was spent in the WAL lab to begin preliminary analysis, which included the inputting of data into Microsoft Excel and FileMaker Pro for further analysis.

Results

The goal of this research is to develop an extensive database on the humpback whale Gulf of Maine population. Extended databases are extremely important when studying long-lived species like whales. This research is now beginning to answer some of the questions that only a long-term study can answer. These results will become part of the BSC database and will be compared with results from earlier years to understand the long-term demographics and behavior of this population. This research is important because it is a continuation of this long-term study and will provide the data needed to understand what happens during the summer of 2007. This information will be placed in the context of both past and future research on this population to provide an important and indispensable link in this long-term demographic study. Analysis using various statistical techniques was used to tease out certain information. When looking at the sex ratio it was found that more females were recorded then males. There were a total of 80 females and 44 males, which made the population seem skewed towards females, with a chi square test supporting the hypothesis that the population is significantly female biased (Fig 1).

	Males	Females
Observed	44	80
Expected	64	64
	5.22	5.22
Degree of Freedom	1	
x^2 =	10.45	
P	0.00122542	
Chi Square Stats	10.83	

Fig.1 Chi square results of sex ratios in Stellwagen Bank in 2007, showing significant female bias.

Next, ratios between mothers and the rest of the population in Stellwagen Bank were run. Statistical analysis of the number of mothers compared to the rest of the population showed the number of mothers out of the total population was 14.7% in 2007, 9.5% in 2006, 12.6% in 2005, and 10.6% in 2004. Chi square tests determined the increase in births from 2004-2007 was just below significant, another year or two in either direction could help more accurately determine the significance (Fig 2).

Percent of Mothers by Year

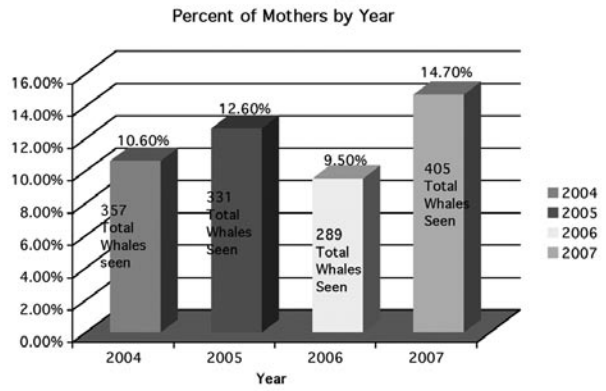

Fig. 2. Calving intervals from 2004-2007. Chi square tests show that the increase in calves is just below significant.

Life Histories tracking of the parents and offspring allows for determination of breeding frequency. Also for individuals with known birth years, we can determine the age of female sexual maturity. Three whales that were seen most during the summer were compared to result in an average breeding frequency of 2.45 years. Births were seen as close as 1 year and as far apart as 7 years (Fig. 3). More commonly whales initially gave birth every three years, then slowed down to five or six years, and then rising again to only two years between births.

Conclusion

In conclusion, so far this study has provided an increased understanding of a number of important factors including the need to continue studies like these to get a bigger picture. Conclusive factors were that an average breeding frequency was 2.5 years (Fig. 3). The possible changes in birthing frequency could be due to full maturation of the female's body. When a whale reproduces they may not have reached full size, which means their bodies are unable to recuperate as quickly after pregnancy. When they reach full maturity, it is possible that their bodies are at their prime and thus able to reproduce which contributes to a shorter interval between births. More research is needed before this could be considered conclusive.

Salt

Year first sighted: 1976
Year of birth: unknown
Mother: unknown
Last seen: 2008

Salt's Calves:

- 1980 Crystal (male)
- 1983 Halos (male)
- 1985 Thalassa (female)
    - 1992 Skeeter
    - 1998 Etch-a-sketch
    - 2001 Shishkabob
    - 2003 Yosemite
    - 2005 unnamed
- 1987 Brine (male)
- 1989 Bittern (male)
- 1991 Salsa (female)
- 1998 Tabasco
- 2000 Mastaza
- 2003 Wasabi
- 2006 Soya
- 2008 unnamed

Fig. 3. An example of an extensive life history record for the humpback whale named Salt. She was first observed as an adult in 1976 and has been seen every year since, including this 2008 season.

The result from looking at sex ratios unfortunately is inconclusive due to several factors. The first problem is that whales are not easily sexed. Females are easier to sex than males because of the strong bond between mother and calf. Once a whale is seen with a calf it will be recorded as female, and if after ten or more years a whale does not have a calf, it is generally sexed as a male. This method isn't entirely accurate since some females may never successfully give birth. The best way to sex a whale is to capture a photograph of their genitalia, and a trained eye will be able to tell whether the whale is male or female. Unfortunately, these shots are difficult to obtain. The second reason the result seen is not entirely accurate is because there were over a 100 individuals whose sexes were unknown. Half of the individuals could not be identified from photographs. In addition, the sex could not be determined for 50 of the identified whales. Thus, the sex ratio of Stellwagen bank will need to be studied more extensively in order to reach conclusive results.

From quickly comparing the increase in the amount of mothers from 2006 to 2007 it seemed like a significant amount. Unfortunately, when chi square was run on the amount of mothers compared to the amount of the rest of the humpback whale population in 2007 the result is to be considered just below significant. Another couple of years in either direction from the years used would most likely allow for a more sound conclusion and a determination of significance. Thus, more research is needed.

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